TRANSACTIONS

OF THE

ILLUMINATING ENGINEERING SOCIETY

FOUNDED IN LONDON 1909 INCORPORATED 1930

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VOLUME VI.—No. 10
DECEMBER, 1941.

32 VICTORIA STREET
LONDON SW1

SESSION 1941—1942

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INDUSTRIAL LIGHTING IN RECONSTRUCTION

By H. C. WESTON (*Fellow*)

(*Paper read on Tuesday, November 11, 1941.*)

Introduction.

Whether the problems of reconstruction should engage any of our attention during the war period is a matter on which opinion is divided. Misconception of the field of reconstruction may suggest that the process is one which cannot, or need not, begin until hostilities cease. But this is only true of a very restricted part of the field and, even so, the general problems that can be foreseen cannot be considered too soon if the process of reconstruction is to proceed on the best lines when the impetus to it need no longer be restrained. In some—and most important—parts of the field of reconstruction the process is not one which can be referred to the future, but is already in action. Very many changes are taking place now which are not merely war expedients, so that the end of the war will find us at a more or less advanced stage of reconstruction rather than at its beginning.

This will be the case with industrial lighting. So, in dealing with its reconstruction we shall have to consider developments during the war and not a programme for the future alone. Indeed, if we are to speak of a period of reconstruction so far as industrial lighting is concerned, we shall have to date its origin certainly not later than the latter part of the first war year. Moreover, there can be no doubt that such new standards of industrial lighting as we may rightly hope will be established generally after the war must be formulated now. Their establishment in those sections of industry upon which the successful outcome of the war so largely depends is an immediate necessity, and not one that can be deferred. We are, in fact, in the throes of what post-war industrial historians may refer to as the industrial lighting revolution.

But even if reconstruction is conceived as proper only in a period at which we have not yet arrived —and whose characteristics we can neither control nor foresee in detail—it is necessary to make an estimate of the state of industrial lighting at the dawn of this period before any useful idea of the nature and magnitude of the task of future reconstruction can be formed.

War-time Reconstruction.

During the past year practically all the resources of the lighting industry have been concentrated on industrial lighting. New war factories have been equipped with installations planned to provide artificial lighting to recognised standards of good practice and some, which are of exceptional interest and merit and will be referred to again, set new standards. Considerable progress has been made with the re-lighting of existing vital factories, but the rate at which this is proceeding is limited mainly by the shortage of labour available for the work of installation. Still much remains to be done and, quite recently, the importance of improving lighting in factories as soon as possible has been reiterated by the Select Committee on National Expenditure (Twenty-first Report, August, 1941), who state that "the cost in labour and materials of making the necessary improvements may be far outweighed by the resulting increases in output." They recommend that every effort should be made by the inspectors of factories, assisted where necessary by the officers of the Production Departments concerned, to expedite improvement in necessary cases. Coming from a committee concerned with wise spending, this recommendation has special force, and is a direct incitement to war-time reconstruction.

The Factories (Standards of Lighting) Regulations, 1941, have also come into force, and have already led to improvements in a number of factories not subject to the requirements of the Production Departments. These regulations apply to less than 10 per cent. of the total number of factories registered before the war, but, in these, there is probably more than two-thirds of the total number of persons now employed in manufacturing industries. Thus a majority of factory workers, as now distributed, are enjoying or, as soon as the necessary improvements can be carried out, will enjoy conditions of lighting which are either up to the standards required by the Production Departments or not worse than those prescribed in the Ministry of Labour regulations. The latter only limit the permissible badness of conditions of lighting. They do not aim to secure optimum conditions which make a positive contribution to the health, morale, and efficiency of workers, and are obviously essential in war-time, when maximum production is imperative. Because the psycho-physical effects of good lighting have been shown in peace-time to improve output, reconstruction of factory lighting now must help to solve our present problem of manpower. It cannot be solved by periodic exhortations and "snappy" slogans without establishing conditions that permit increased individual effort to be sustained.

Post-war Prospects.

There is, at present, little to suggest to most of us that hostilities will cease before considerable further progress has been made in the improvement of factory lighting. Thus, at the beginning of the period of reorganisation for peace the condition of industry in respect of artificial lighting, will almost certainly be substantially better than it was before the war. Nevertheless, a large number of factories, many of

them small, will still be unsatisfactory, and a number of new factories, and those that must be partly rebuilt, will have to be constructed and equipped for good lighting.

Bomb-damaged factory buildings offer opportunities for the improvement of natural lighting, in the process of repair of which full advantage should be taken. Some of these have already been missed. A very large part of one side of an old multi-storey food factory, not a mile from London Bridge, has recently been rebuilt in the original style, with unnecessarily small windows matched with the few remaining in the undamaged portion of the façade. If this is intended as a temporary repair it might have been better, in a target area, to provide no windows or to make them even smaller. That they have been reconstructed in the old style suggests that the question of better lighting was either not considered or dismissed as unimportant. It is partly to prevent similar occurrences that it is necessary now to draw attention to lighting in relation to reconstruction.

But, while the extent of the reconstruction of artificial factory lighting required after the war will probably be considerable, it would be unwise to conceive it as vast, unless we are visualising the general establishment of ideal conditions. To achieve this, no doubt many quite recent installations would have to be reconstructed.

Compared with the last war, industry is now much more dependent on artificial lighting and, as a result, workers are likely to become more light-conscious. Those who work through the war under bad or indifferent conditions are likely to become more and more dissatisfied with them, even if the impulse to complain continues to be inhibited. On the other hand, the large number who will see the war through in the vital factories will experience conditions of lighting which, for many of them, represent a new high standard. Those who subsequently return to other factories will look for conditions at least equally good. It will be surprising if there is not also a parallel growth of interest in good factory lighting among many of those concerned with management—indeed, this is already becoming apparent.

For these reasons the author does not believe there is likely to be any lowering of the minimum illumination for working areas below the level prescribed in the present Standards of Lighting Regulations, nor that factories which do not work shifts, nor more than forty-eight hours per week, will continue to be exempted after the war. The minimum desirable illumination is independent of the illuminant and applies both to daylight and artificial light.

Natural v. Artificial Post-war Factory Lighting.

Before the war artificial lighting was used in the average factory for some 10 to 15 per cent. of the time worked. Will this percentage tend to rise or to fall after the war, and hence, what will be the relative importance of natural and artificial lighting in industry?

If the outcome of the war is nothing better than an armed truce, there may be a growth of windowless and underground factories entirely dependent on artificial lighting. But, only a deep sense of insecurity seems likely to encourage such a development, in face of the reaction in favour of daylight that must be expected to follow the experience of years of restriction. There are, of course, other reasons than that of security which can be advanced for windowless factories, but, of these, the argument from congestion will disappear if plans for the control of building and location of industry now contemplated become operative.

There are also other reasons than a natural preference for it which may lead to a greater, and in some sections of industry perhaps an exclusive, dependence on daylight. Of these, the most cogent is the need to give all men work to do. In planning for peace a permanent solution of the problem of employment is indispensable. Hitherto, society has found no solution, except the temporary one that involves planning for war. This inevitably intensifies the problem in the next period of peace, since, at the stage of war, it necessarily encourages a disproportionate development of mechanical productive capacity. It is difficult to avoid the conclusion that the only rational solution involves rationing employment by limiting the permissible working hours, so that everyone may share the available work. Under this plan, it is not imposible that, except for necessarily continuous processes, industry could confine its operations within the hours of daylight all the year round. After the last war such a plan was actually operated for a time, in a few factories, to achieve an equitable distribution of employment.

If this suggestion is regarded as Utopian this is exactly what it is. But the popular acceptance of "Utopian" as a synonym for "impracticably ideal" is an injustice to a far-sighted medieval visionary. In his "Utopia" Sir Thomas More described a society whose organisation bears many resemblances to the new order we are already pledged to construct, and he anticipated much that has since been accomplished in successive periods of reconstruction. If only for this reason, his plan for working hours deserves serious consideration. It was, however, operative in certain professions before the war, and may well be more generally adopted after. More's account is worth quoting briefly, and runs as follows:—

> . . . take heed that no man sit idle, but that everyone apply his own craft with earnest diligence. And yet for all that not to be wearied from early in the morning to late in the evening with continual work, like labouring and toiling beasts. For this is worse than the miserable and wretched condition of bondmen. Which, nevertheless, is almost everywhere the life of workmen and artificers, saving in Utopia. For they, dividing the day and the night into twenty-four just hours, appoint and assign only six of these to work; three before noon, upon which they go straight to dinner; and after dinner, when they have rested two hours, then they work three hours, and upon that they go to supper. . . . All the void time that is between the hours of work, sleep and meat that they be suffered to bestow every man as he liketh best himself; not to the intent that

> they should misspend this time in riot or slothfulness, but being licensed from the labour of their own occupations, to bestow the time well and thriftly upon some other science, as shall please them. . . . But here, lest you be deceived, one thing you must look more narrowly upon. For seeing they bestow but six hours in work, perchance you may think that the lack of some necessary things hereof may ensue. But this is nothing so. For that small time is not only enough, but also too much for the store and abundance of all things that be requisite either for the necessity or commodity of life; the which thing you also shall perceive, if you weigh and consider with yourselves how great a part of the people in other countries liveth idle . . . if all these were set to profitable occupations, you easily perceive how little time would be enough . . . to store us with all things that may be requisite either for necessity . . . or for pleasure,*

Though the wants of man have greatly increased since More's time, four centuries ago, so also have the means for production, so that a short working day would still suffice for their satisfaction if we plan for the elimination of unemployment. More's plan is worked out in detail, and is well worthy of study by anyone interested in the larger problems of reconstruction.

While the immediate post-war years may bring a great activity in industry to make good rapidly some of the shortages war inevitably creates, the author believes that rational plans for reconstruction must include the regulation of hours of work in such a way that work is no longer very unequally distributed, and denied altogether to many. The productive capacity of industry under increasing and increasingly efficient mechanisation, and—among other things—better lighting, as well as the alteration of markets which seems likely if a stable peace is established, appears to offer only the choice of less work for all or more widespread permanent unemployment.

But the proper adjustment of hours of work in the modern labour-saving world does not necessarily involve a shorter working day. Other arrangements are possible, and it may be that a shorter working week would be more satisfactory in general, or at any rate for certain industries. If so, the percentage of working time for which artificial light has to be used will not alter appreciably.

However this may be, artificial lighting for industry ought to be planned with a more liberal view of the functions it should serve than was current in pre-war practice. If it is based on the dictum that "the *one and only* object of an industrial lighting installation is to enable the operatives to see clearly, quickly, and easily the objects on which they have to work,"† it may well prove unsatisfactory because it ignores the fact that men and women are just as human in the factory as out of it, and are affected—often greatly—by visual impressions of their environment as a whole.

Effects of Unsatisfactory Artificial Lighting.

War-time experience has shown that lighting giving good visibility *of the work* is not necessarily good enough *for work*. It may only create conditions in which the flesh is willing but the spirit is weak. In a previous paper* the author drew attention to the shortcomings of much of our industrial lighting in this respect. But, as it should be interesting to have a worker's views in his own words, the following quotation is given from a very recent letter:—

> I take the liberty of sending this letter because (a) the contents of it may be of interest as information, and (b) the Board† may be able to render assistance in solving the problems involved.
>
> My occupation is wireless engineer, and I am employed in the workshop of Messrs. X at Y. With several others of both sexes (ages ranging from sixteen to forty years approximately), I am engaged on the construction and servicing of radio and speech broadcasting equipment, most of this being Government work.
>
> Since the outbreak of the war the workshop has been permanently blacked-out day and night, summer and winter. The black-out is complete except for a *few* panes of glass up in the lofty roof which are uncovered by day.
>
> The rest is all tarred over. The amount of daylight entering is not sufficient in itself to permit work being carried out, and work is effected by artificial light continuously. The interior of the workshop is definitely dingy and dismal in appearance, corresponding to the "depressing" of the Board's Emergency Report No. 1. The lighting is, to the best of my powers of description, average for the period, say, 1910-1920—with minor additions (not alterations) during the last few months. A rather alarming revelation has been our head of department's recent assertion that there is no danger or harm in continuous all day work by artificial light, presumably indefinitely.
>
> I am of opinion that there is danger, both in 100 per cent. artificial light and in an haphazard mixture with daylight, and this is a danger which is increased in the absence of any specialised planning. I feel that the ill effect is insidious, i.e., the decrease of individual efficiency is, perhaps, too slow to notice from day to day or week to week, but, marked over a period of months, or years, as it has become. The manager assures us that there is no alternative, i.e., there is no practical way of temporarily blacking the place out so that it could be removed by day, or even removed for the summer. . . .
>
> A point is that the management has shown no initiative in trying to introduce anything to alleviate the difficulties. I personally have suggested some, with no result—so have others. . . .
>
> Please do not think I am just moaning, or deliberately agitating. The nearest that I am to an agitator is wrapped up in the fact that I happen to be older than my colleagues immediately around or adjacent. The tendency among the younger ones is just to look forward to knocking-off time, especially Saturday afternoon, and sink into a "fed-up" attitude to the rest. In a nut-shell, the whole establishment comes to be referred to as the "dump." It just goes on like this, as any vicious circle will, for an unforseeable long or short time Both management and personnel go on, being perhaps too unwieldy to modify or adapt on the one hand, and just trapped on the other. I'll refrain from trying to decide on paper here how much of this letter is the result of intuition and how much due to depressing working conditions and the level of the demeanour of my colleagues. There may even be suppressed neurasthenia somewhere higher up.
>
> Incidentally, I have lost hours of work during and since the blitz—one has to strike a balance between losing time and possibly heading for a spell of several days off. One interesting personal note is that a Sunday out in the country (not over energetic) gives me a feeling of improvement during that evening that is frequently

* "The Utopia of Sir Thomas More," Book II., Chap. IV. Of Sciences, Crafts and Occupations.

†"Modern Factory Lighting," p. 1.

* "Industrial Lighting in War-time," Trans. I.E.S., Vol. VI., 1.

†Industrial Health Research Board.

followed by a definitely strained feeling for a day or two to follow.

This seems to me to be an interesting point for observation. It may be due to strain on a retina insufficiently used to bright daylight. I could write on, but hope that I have at least contributed something a bit worth while on a subject that must be paramount in the minds of your Board. . . .

Here is a case which is fairly typical of a considerable number of factories, and the letter gives a good description of the effects likely to be produced on the workers. On investigation it was found that the lighting installation is of the localised-general type using standard dispersive reflectors. Thus the mounting height is rather low and the light sources are not regularly spaced.

In spite of this none of the Standards of Lighting Regulations is violated, and the illumination at workplaces is in accordance with the I.E.S. recommended values for the class of work done. Yet the results are clearly unsatisfactory, mainly because the method of lighting fails to give the interior a cheerful and satisfying appearance. The building is, admittedly, not the answer to an illuminating engineer's prayer, but there are many which present similar difficulties. If the mounting height and the number of light sources are increased, and their spacing altered, some improvement can be effected, but there will still be a noticeable and disagreeable black ceiling, owing to the height of the roof, even if partly open-top, or diffusing-glass fittings are used.

An auxiliary installation is really necessary for the specific purpose of illuminating surfaces which cannot otherwise be given sufficient brightness, but which occupy an appreciable part of the field of vision when looking about the shop. An alternative, which might be feasible in this case, is to provide a false ceiling. But quite possibly the agreeable subjective effects of lighting by fluorescent tubular lamps would largely offset the contrary effects of a dismal background. We all know it is possible to ignore, or make light of, the objectionable features of a situation if it presents one that is particularly good or welcome. The converse is equally true and represents the present situation, so that the problem might be solved merely by introducing a very welcome feature, even if the now dominant objectionable feature is not removed.

While it has never been established that the continuous use of uncorrected artificial light is harmful in itself, the popular notion that it may be is certainly based on genuine experiences of discomfort, due to common lighting faults, and not only on mere prejudice against the non-natural. And, of course, the risk of incurring such experiences may be considerable in the absence of careful planning. In this factory the lighting installation, like Topsy, "just growed," as it has done in many factories. But, unlike natural growth, it has been too one-sided, and directed from the narrow viewpoint of getting light where the need for it is most obvious—on the work.

Social Significance of Factory Lighting.

The conditions described not only compare very unfavourably with those to which the worker may be accustomed during the day in normal times, but it is very difficult for him to avoid brooding on them, especially if he can foresee no amelioration for a long time. Insidiously their effect grows, and if it does not impair actual physical capacity, it undermines morale, and consumes in useless fretting mental energy that might be freed for the drive to objective achievement. It must also be realised that many other conditions, both in and out of the factory, fall short of the optimum—especially in war—and combine to engender discontent. When this becomes sufficiently conscious the grievance tends to become centred about what seems to be the most unnecessarily defective or unusual and obtrusive condition.

This is often artificial lighting, which is likely sometimes to receive even more than its fair share of blame. But discontent, to whatever causes it may be attributed, is so contagious and so disastrous that no effort should be spared to reduce it. The improvement of industrial lighting will not eliminate it, but bad lighting should be removed from the list of its contributory causes.

The human effects of environmental conditions experienced during the hours worked in factories, and other places of employment, are not confined to working hours. They cannot be assessed merely in terms of quantity and quality of work done, but have a significant influence on the whole life of the individual and of the community. This is no exaggeration, as very little reflection will show. Leaving out of account—as due only to exceptionally bad conditions—special pathological effects and accidents, whose consequences quite obviously reach beyond the industrial unit from which they spring, consider for a moment, and with particular reference to industrial lighting, the diverse and far-reaching consequences outside the factory of imperfect conditions within it.

The man who leaves the factory unnecessarily fatigued, or "fed-up," sees the world through dark glasses. Just as he cannot leave his sensibilities outside the factory when he goes to work, nor can he leave behind all the effects of the factory when he clocks-out. He brings his gloom or his irritability into the home and at once extends the influence of the factory conditions to the family group, which in turn reacts upon a wider circle. His other social contacts are also affected in some degree; so are his leisure pursuits, and even his political views.

To attempt to trace all the consequences of conditions to which workers are exposed, during about half their waking hours, would take us far afield. But, the importance of good environmental conditions at work is only fully apparent if we bear in mind that the experiences they occasion cannot fail to extend their influence beyond the individuals immediately affected, and beyond the hours of work.

By thinking of industrial lighting—which is certainly one of the most important of these conditions—as belonging to a water-tight compartment in the structure of modern society, its real sociological significance must necessarily be obscured. It is in the fuller context of life, as an integration of interdependent spheres of activity, that it must be seen in

planning for reconstruction. This is equally true of other major fields of lighting.

Lighting with Fluorescent Tubular Lamps.

The artificial lighting of some of our new war factories, from which daylight is entirely excluded, is exceptionally good and satisfying. Two of these, which the author has recently seen, may be mentioned. The first is a small one where the assembly of radio chassis is done. Five-foot fluorescent tubular lamps are used and are arranged end to end in ten rows, one row above the centre line of each bench. The lamps are mounted in continuous troughing attached to the ceiling, and are about seven feet above bench level. The chokes are banked at the ends of each row, and the glow-discharge switches are enclosed in shrouds covering the lampholders. The illumination is about 15 ft.c. on the benches, and varies very little over the whole working area. The general appearance is extremely good and gives the impression of natural lighting from roof windows. There is no glare, and the operatives, who are working twelve hours a day apparently without strain, are very pleased with the conditions.

The second factory is much larger and is lighted by 1,500 tubular lamps. The building is a reinforced concrete structure, the roof of which consists of a number of arches, and is so designed that supporting pillars between the spans are unnecessary. The lamps are mounted in troughing carried by conduit attached directly to the roof. There are two rows of lamps in each roof span and the spacing of the rows is about equal to their height above floor level. In some sections of the building the lamps are arranged end to end in each row, while in others they are spaced about five feet apart. These arrangements provide illumination levels of about 7 and 14 ft.c. respectively, which are quite adequate for the work. The roof and upper part of the walls are painted a matt white, and, as in the previous case, the chokes are banked at the ends of lamp rows.

The appearance of the interior is excellent and very natural. On entering the building on a bright sunny day one is conscious only of the expected change of brightness level but not of any qualitative change, and the light sources are not obtrusive. Looking across the factory, it is impossible to see the lamps at all in distant bays, where it is difficult to believe that daylight is not being admitted. The most striking testimony to the acceptability of the installation was given involuntarily by a visitor who, having been conducted through the building, was asked by the manager, " How did you like the lighting? " and replied, " What lighting? " He had to be taken back to be convinced that the factory was, in fact, entirely dependent on artificial lighting. This case is a good illustration of the truth that the more thoroughly an industrial lighting installation does its job the less notice will it attract.

Other, and more extensive, installations using continuous rows of these lamps are now in operation and proving highly satisfactory. In the case of one large factory the management state that output has increased by 25 per cent. since this system of lighting has been in service. Unfortunately, photographs of these installations cannot now be obtained. The use of fluorescent tubular lamps for localised-general lighting—for which they are obviously very suitable —is also increasing. In addition, they are being used for indirect lighting in small rooms devoted to special processes where an average illumination of 30 to 35 ft.c. is obtained. The need for a subjectively satisfactory alternative to daylight is becoming increasingly apparent in other interiors, e.g., hospital wards and offices where windows have been bricked up, and here, too, fluorescent tubular lamps are proving very valuable.

Source Brightness and Dazzle.

One of the most important conditions for the improvement of industrial lighting is reduction of the brightness of lighting units, and of the brightness contrast between them and their surroundings. For units used for general lighting the present regulations permit a brightness which, though tolerable, is far from ideal. It may be a thousand times the brightness of the work, or the average brightness of the background against which the units are seen. But a ratio of 100 : 1 or less is more comfortable, and more characteristic of interiors lighted by diffuse skylight. It is true that compliance with Regulation 3c will often require the enclosure of incandescent light sources, whether used for general or local lighting, in low brightness fittings. But, even where there is no obvious danger of glare due to reflections of the source, the use of low brightness diffusing fittings greatly improves the prospect of satisfactory results from a direct lighting installation.

The war has, unfortunately, tended to discourage the use of glassware in industrial fittings, but there is no doubt that without it direct lighting by ordinary high brightness sources does not give complete satisfaction, at any rate in whole-time use. The gaze of workers is never wholly confined to horizontal and downward directions. More or less frequent glimpses of the light sources themselves are inevitable, even when the Lighting Regulations are complied with. These are disturbing and vaguely unpleasant, as is the peripheral view of a nearby bright source whose angle of elevation from the eye does not greatly exceed twenty degrees. Also, there are almost always some polished objects within the shifting field of vision from which reflection is troublesome, and only a much more detailed study of particular situations than the illuminating engineer usually makes is likely to disclose them. This is primarily why, after a recent trial of installations using fluorescent tubular lamps and, alternatively, tungsten lamps in standard dispersive reflectors giving the same illumination, a worker remarked that " with ordinary lighting the eyes get tired sooner and the day seems much longer."

Where the work involves handling and inspecting polished articles, direct lighting with high brightness sources can cause an appreciable reduction of out-

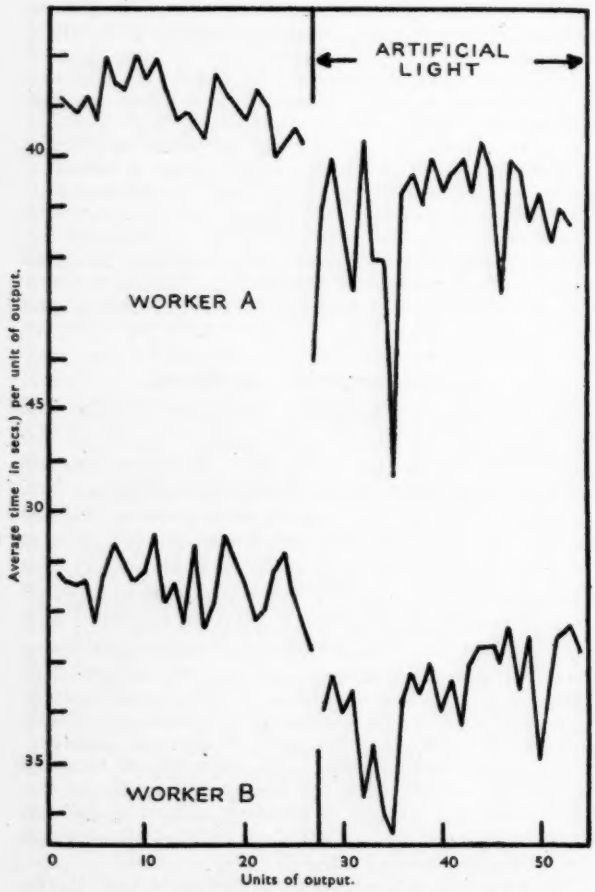

Fig. 1. Showing effect of artificial lighting in reducing output owing to reflected glare.

put, as shown by the accompanying graph (Fig. 1). This refers to the work of two women examining cartridge cases, whose rate of working is seen to fall and become more variable under artificial lighting. They stated that "the electric light produced a disturbing dazzle on the brass caps of the cases which made the operation more difficult and fatiguing. In addition to the dazzle or glare, it was also evident that the cases were less uniformly illuminated than in ordinary daylight and the visibility of the defects was in consequence reduced."*

The actual fall in output shown by the two curves is 6.7 and 5.6 per cent. respectively, and if this and similar work is now done all day with similar artificial lighting the loss of output must be serious. The report from which these curves are reproduced also draws attention to the fact that both the colour and brightness of the background to the objects to be examined are often unsuitable and "fail to provide the restful contrast which is essential to comfort and efficiency."

*S. Wyatt and J. N. Langdon, "Inspection Processes in Industry." Industrial Health Research Board Report No. 63, 1932.

Brightness Engineering.

But, in reconstructing industrial lighting, the possibility of altering both the background and the work material should be considered. Illuminating engineering has always involved the art of arranging brightnesses for the service of man. But in general, and certainly in the industrial sphere, achievement of this end has been attempted in practice only by planning an arrangement of light sources. Except in rare cases, the surfaces to which brightness has to be imparted have been regarded as outside the control of the illuminating engineer, and to be accepted as he finds them. The expression "illuminating engineering" itself suggests the control of light, rather than of both light and what is to be lighted. It has not tended to encourage the idea that the first approach to any lighting problem should be a detailed and critical survey of the field to be lighted, with the object of suggesting what, if any, changes might be made to facilitate a plan of lighting for achieving the best possible arrangement of brightnesses.

The recommendation in the Fifth Report of the Departmental Committee on Lighting in Factories concerning the maintenance of light-coloured interior surfaces has done something to rescue this obviously important aspect of factory brightening from the oblivion into which it was in danger of sinking, owing to the traditional circumscription of the illuminating engineer's province, and his preoccupation with lighting equipment. The black-out has performed a similar service by attracting more attention to the nature of exterior surfaces to which brightness has to be given, and to the possibility of modifying these surfaces themselves to produce the best arrangement of brightnesses.

In the industrial sphere the practice of brightness, rather than illuminating, engineering must bring under review, as potentially modifiable, everything presented for lighting. Not only structural surfaces, but machines, benches, tools, and, as already mentioned, even the material on which work is done, must be regarded, in the first place, not as immutable, but subject to change, if this is desirable to improve visibility and is reasonably practicable.

Of course, for technical reasons, it will not be possible to suggest the modification of some objects in the field, however desirable this may be. These the brightness engineer must ultimately accept as given. But, there may be others capable of modification—in consonance with a rational plan for production and product—which are as he finds them simply because there has hitherto been no fully comprehensive planning taking visibility into account.

Thus, in contrast with illuminating engineering as now generally practised—which adapts lighting methods and equipment to illuminate objects—brightness engineering embraces also the converse process. It involves co-operation and consultation, not only with factory and plant engineers, but also with production engineers, designers, and even with sales departments, whose demands sometimes impose on the factory the use of designs, materials, and

finishes which could be avoided if the difficulties they occasion were pointed out by the brightness engineer.

Reconstruction for both visibility and amenity involves the metamorphosis of the illuminating engineer. And, as a brightness engineer, he cannot plan lighting installations merely from building plans, even if they include the lay-out of plant. He needs more data, and his specification may have to be accompanied by a series of recommendations concerning decorations, window blinds or shutters, fixtures and materials. But, by this wider planning, the best possible results are more likely to be achieved than by present methods.

There is already a tendency for matt to replace polished finishes for manufactured articles. One example is the modern typewriter, the body of which has a matt finish. No doubt this is done for the benefit of the user, who is thus protected from glitter, but it must be equally welcome to those who assemble the machines in the factory, and it may permit the use of a method of lighting which would otherwise be unsuitable. An alternative material, colour, or finish is probably quite practicable for many of the products of industry, as well as for some of the tools and equipment worked with.

Illumination Values.

Little mention of illumination values has been made in this paper because the I.E.S. ranges include values suitable for all industrial operations. The values recommended for specific types of work are believed to be generally of the right order, though closer analysis of the nature of different tasks may show the need for reassessment in some cases. Illuminations of 100 ft.c. and more are now occasionally used for very fine work in factories, and recent research has confirmed the need for such values if the unaided eyes are used for continuous discrimination of fine detail. The possibility of further regulations defining illumination levels for different classes of work is, of course, still open.

Reconstruction by State Planning and by Rationalisation.

As soon as State regulation occurs the stage of central planning for reconstruction is passed, for the time being, and the stage of administration is reached. Factory lighting is unique in having reached this stage, for we can hardly regard the war-time restrictions in other fields of lighting as marking a similar stage in the process of reconstruction!

The statutory requirement of sufficient and suitable lighting in all factories is general enough to be interpreted in terms of the ideal. But the intention of existing legislation is not in this sense, though future legislation may be more so. We have seen that the present Lighting Regulations do not exclude the possibility of conditions which are unsatisfactory at least in war, and probably also in peace. But, reasonably interpreted and enforced, they do involve extensive reconstruction and the eventual abolition of grossly defective conditions of lighting in factories.

The rationalisation of industry, as a part of the more rational order we may hope will emerge from the present upheaval, requires, however, that reconstruction shall aim to achieve the establishment of optimum conditions. In general, this involves the naturalisation of artificial lighting to the extent that light sources, whether primary or secondary, become unobtrusive in virtue of their size, brightness or location; that the brightness levels in all parts of the interior are apparently proportional to those agreeable in daylight; and that the quality of light preferably resembles sky-light. This is not a counsel of perfection, for we have seen that already its realisation is being closely approached in some factories.

DISCUSSION

Mr. H. E. Chasteney (Deputy Chief Inspector of Factories) paid tribute to Mr. Weston's wide experience and research in industrial lighting, and to his very broad outlook upon the problem of reconstruction which had made the paper particularly interesting. When war broke out the new Factories Act had only recently been introduced, and had not got properly into its stride. Everyone had been looking forward to substantial improvements in safety, health, and welfare conditions and, not least, in factory lighting for which requirements were introduced into that Act for the first time. Fear that the war would dash their hopes to the ground had, fortunately, not been realised. The past year had seen striking progress in industrial lighting, partly as a result of the needs of production and partly owing to the pressure of legislation; and, in fact, reconstruction had already commenced.

The present afforded great opportunity of gathering experience for the introduction of the further measures of reconstruction which would be needed after the war. One of the most valuable assets that we should inherit would be a new attitude on the part of the workers towards lighting in general. They were becoming light conscious. It was not always so. The poor level of illumination in some factories, particularly in the old staple industries which were often handicapped by antiquated buildings and haphazard lighting installations, had persisted to a largs extent because succeeding generations of workers had grown up with bad lighting conditions and had come to tolerate them; indeed, they hardly realised that they were bad. The factory department normally received many hundred complaints during the year about matters connected with health and welfare, but they included remarkably few complaints concerning lighting. There had been a noticeable increase, however, since the question of improved industrial lighting came to the forefront. He declared that very few industries could hold "a foot candle" to the lighting industry and the efforts that it had made to bring about improvements; it was part of the function of the lighting engineer to go ahead and to assist progressive firms to attain higher standards than ordinarily could be enforced by law. In the factory department they had to lean heavily on the requirements of the Act and Regulations; one of their chief functions was to

harry the stragglers, and he thought they had made some progress in that direction. The standard of 1 ft.c. recommended in 1938 had now become a minimum standard of 6 ft.c., which was no mean improvement. He was therefore a little disappointed to hear Mr. Weston's reference to some conditions of lighting as "not worse than those prescribed in the Ministry of Labour Regulations."

He welcomed Mr. Weston's emphasis on the fact that general environment and surroundings were of as much importance as the actual lighting standards. He had visited a number of workrooms lit according to the standard of the Ministry of Labour Regulations which, with their light coloured walls and ceilings, were much more cheerful and desirable places than many workrooms with a higher standard of lighting, but with dark walls and ceilings. He suggested that there should not be too much dependence on an absolute foot-candle lighting standard; it was a useful yard-stick, but other factors were very important. The lecturer had well said that the purpose of lighting was not merely to enable people to see their work, but to add to the amenity of their surroundings.

Mr. Chasteney agreed that it was very difficult to predict post-war conditions. He thought the primary demand would always be for natural lighting. He was rather puzzled by Mr. Weston's statement that there were other reasons than that of security for windowless factories. For years they had been attempting to get more daylight into factories, and modern building construction opened possibilities of having factories which were practically glasshouses. It was generally recognised that good natural lighting was not only healthful, but assisted production. Unfortunately, the factories which had been most progressive in that respect were those which had found the greatest difficulty in complying with black-out restrictions and the needs of glass protection. He hoped that at the end of the war we should be able to look back on windowless factories as a nightmare and forget all about them.

Mr. A. E. Iliffe sounded a note of warning against too much regard being paid to daylight illumination values. One assumed daylight to be perfect—even Mr. Chasteney had said he would like to see "glasshouse factories"—but it must be borne in mind that daylight varied to a considerable extent. The author had stated that artificial lighting was used in the average factory before the war for some 10 to 15 per cent. of the time worked. Those figures were probably correct, but it was unfortunate that the value of the lighting was not better understood. Artificial lighting was usually needed for practically the whole of the time that a factory was working. The adage that natural lighting was better and that artificial lighting should not be used when the sun was shining had led to the great diversity of opinion on lighting values. It would be absurd for any lighting engineer to leave out of account in his review of what was to happen in regard to post-war lighting the development of fluorescent tubes. They must make up their minds whether their optimum of conditions was to be decided from the material, the labour, or, perhaps, the financial standpoint. He was not convinced that all the lighting brains in the world should be taken off tungsten and put on fluorescent tubes. The experience of one's younger days when walking along a promenade proved that daylight could be very obtrusive. (Laughter.) It might be that the lighting engineer would have to exercise his ingenuity to tone down the daylight and bring it into conformity with artificial lighting. He congratulated the author on one of the most interesting papers which it had been his good fortune to hear.

Mr. E. W. Murray agreed with Mr. Weston's remarks regarding the metamorphosis of the illuminating engineer. Apart from the need to provide the necessary contrast, one or two other matters might require his attention, as was shown by the following illustration. The reillumination of an existing factory by fluorescent tubular lighting had shown the extent to which old illuminants contributed to its heating. Even though the black-out screens for the windows and roof-lights had reduced the heat loss from the building, an additional boiler had to be installed to maintain the temperature at a reasonable level.

The speaker then referred to the use of lighting as a safety feature on some dangerous machines. The Committee of the Rubber Trade Conference dealing with the guarding of calenders and extruders had agreed that (1) each bowl nip of a calender should, when the bowls were in motion, be efficiently lighted throughout its entire length, and (2) the lighting sources should be so placed and screened as to illuminate the nip with the minimum of direct or reflected glare from the bowl surface to the calender worker.

There was another phase of safety lighting often missed, even by the illuminating engineer, namely, in those cases where the law required a guard for some otherwise dangerous operation. This guard must be placed in such a position that the operative had to look through it in order to feed or to see the work in progress. The guard would be a well-lit feature of the operative's field of vision. Furthermore, he would be expected to look through the guard to see the work, which had a much lower order of illumination, owing to the shadows from the guard. Therefore one must sympathise with the operative who took off the guard because, he said, quite rightly, that it prevented his seeing his work. In such cases the working zone outside the guard should be illuminated to a higher degree than the front surface of the guard or the area surrounding the machine, thus rendering the guard a more or less inconspicuous feature in the operative's field of vision.

He endorsed what the author had said about the psychological effect of the dark ceiling or background. Managements must be frequently urged to introduce colour schemes, not only for walls, etc., but also for the machines themselves. By so doing a considerable amount could be done to relieve depression and bring a more pleasant atmosphere into factories.

Lastly, said Mr. Murray, one must not lose sight of the fact that trouble by reflection from the work was not confined to polished articles, it might also be caused by articles that were wet or oily.

Dr. J. W. T. WALSH had only one remark to make on this very interesting and comprehensive paper. The author said that the possibility of further regulations defining illumination levels for different classes of work was still open. He would like to go a good deal further. He thought Mr. Weston would agree that there was a very large field for detailed consideration of the illumination required for many of the principal classes of work carried out in our factories. The Factory Lighting Committee dealt with factories in general, hinting that one day they might extend their investigation to specific industries. He hoped that that would be an important feature of the work of reconstruction, the main factories being dealt with first, and later the smaller but nevertheless important industries.

Mr. GEO. SMITH said that in constituting its Post-War Development Section, the Ministry of Works and Buildings had not yet considered the factory lighting side, but after that meeting he would certainly take care to bring the matter to the front. He always found a very brightly lighted ceiling a little disturbing unless it was accompanied by light walls.

Mr. A. CUNNINGTON supported the author's plea for co-operation with the designer in the early stages of building. Co-operation had undoubtedly reached a more advanced stage on the heating side than on the lighting. There was a general tendency to design modern buildings in such a way as to render them suitable for the introduction of heating; surfaces had been designed with the object of reducing heat loss, and other features had been incorporated which made the heating engineer's job of installation comparatively simple. He was optimistic that this co-operation would be extended to the lighting engineer. The heating engineer probably had an advantage over the lighting engineer in that he could claim that improved heating would reduce the fuel bill, whereas the latter's claim related mainly to better lighting and only indirectly concerned monetary saving.

Mr. Weston's quotation from "Utopia" was very interesting. No doubt Sir Thomas More had not considered whether the people to whom he recommended his ideal conditions could afford to introduce them, but in the case of lighting improvements it was not a question whether we could afford them but whether we could afford to be without them. Looking at the modern structures one imagined how horrified the wealthy factory owners of the middle of last century would have been had anyone suggested that their factories, many of them ramshackle buildings situated in slum areas, should be pulled down and reconstructed. The cry would have gone up that they could not afford it.

Mr. Cunnington then mentioned two personal experiences showing co-operation, or the lack of it, when dealing with lighting and structural design. Some years ago the Southern Railway introduced a platform surface consisting of an asphalt in which was embedded light granite chippings. He pointed out that this greatly improved the platform lighting, and he urged that this type of surface should be adopted as a standard; but, unfortunately, because it was slightly more expensive than standard asphalt, it never became generally adopted, although the improved lighting effect would undoubtedly have justified fully the extra initial expenditure. In the other case instanced his company had constructed some semi-arched platform roofs of concrete in which the main ribs supporting the roof were constructed on the inside surface, and as fluorescent tubes had been adopted for lighting the roof, this meant that the vista of lighting was considerably obstructed by the heavy concrete formations at intervals. As a result of his suggestion to the Engineer's Department later roofs were designed with the reinforced structures entirely on the outside, thus ensuring an uninterrupted roof surface from which the lighting could be very effectively carried out. This proved that such matters could be given attention in the early stages if sufficient interest were aroused. Excepting cases of buildings such as warehouses whose designers were unaware of the specific use to which they were to be put, there was no reason why there should not be the happiest co-operation in the early stages between designers and lighting engineers.

Mr. F. C. SMITH complimented the author on the wide outlook that he had displayed in preparing his paper. In the minds of some people reconstruction merely meant rebuilding. This surely was a very limited outlook. The object of reconstruction was to bring about better social and moral conditions whereby each class of the community could live having regard to the rights and privileges of others. The I.E.S. and other technical bodies could help in reconstruction by using their technical skill and knowledge for the benefit of all. Mere profit-making was surely not the sole reason for working eight to ten hours a day in a factory. Good lighting was necessary in industry to secure the best results, but good lighting was also necessary in the home in order to facilitate the enjoyment of music and other arts during leisure hours.

Mr. L. G. APPLEBEE was reminded by Mr. Smith's last remark of the importance of decoration and its influence upon the individual worker. He was one of those who thought there was a saturation point in lighting where even the doubling of the units might have very little appreciable effect. Much attention had been given to the cutting tool, the surface requiring drilling and the edge of the sheet metal which had to be bent, but very little to the machine and its surroundings He had visited a factory recently where the machines had been painted in brilliant colours, thus greatly improving the amenities. There should be a breakaway from the idea that machines must be painted service grey or black. Later the colour schemes could be extended to the runways and girders. Combined with the greatly improved lighting system to which they were confidently looking

forward, this would brighten the lives of the people who had to spend so many hours in the factories.

Mr. J. S. Dow remarked that the author's emphasis of the importance of lighter and more agreeable surroundings was the outcome, not only of idealism, but also of practical sagacity. He recalled hearing Mr. Iliffe on one occasion refer appreciatively to the good effect of a harmonious colour scheme in a certain factory. It was good policy to make a factory interior, so far as was possible, a pleasant place rather than a depressing one, so that work was done under congenial as well as efficient conditions. A parallel case was presented by the movement towards more cheerful conditions in schoolrooms. Improvements in decoration and lighting had made elementary schools much more pleasant places, with the result that the outlook of children had been changed and they no longer regarded going to school as a penance and something to be avoided. Mr. Dow mentioned the case of a small building recently converted into a factory, which he had recently visited. The building was dingy and old-fashioned, and the access of daylight was poor. Yet the scheme of colouring, with cream walls and details picked out in blue, had been blended so skilfully that one received the impression of quite a cheerful well-lighted interior.

Mr. Dow fully endorsed the author's reference to brightness engineering and his plea for a specification of "comfort conditions." The desirable "quality" of lighting would never be generally available until it had been successfully defined. This, he thought, was by no means impossible; it was largely a matter of determining the order of brightness, and involved careful study of the degree of diffusion of the light and the nature of the background. Such study, coupled with investigations directed to individual industries, should form one of their principal approaches to the reconstruction problems of the future.

Mr. R. MAXTED endorsed the author's remarks in regard to the psycho-physical effects of good lighting. On the broad basis of the economics of a factory the question at issue was not that of being able to afford suitable lighting, but of being unable to afford unsuitable lighting. Managers of factories should be led to realise that the lighting engineer could help them considerably to increase production, which was very important at this time of labour shortage.

Mr. R. O. ACKERLEY agreed with Mr. Iliffe that there was plenty of scope for artificial lighting during the very erratic hours of daylight that we had in this country. Progressive improvements would lead to its greater use. Then tendency was for people to demand the best light available. The trouble was that in so many factories at present there was a feeling that daylight, even in its worst form, was better than artificial light. He was interested in the possibility of altering the actual work to suit the lighting. They had recognised for a long time the need for the lighting engineer to consider the question of background. Mr. Weston had mentioned a few points for consideration. Was there any reason why, for example, wires should not be enamelled in light colours instead of a uniform black. The author had given as an illustration the matt finish to typewriters. No doubt its primary purpose was to meet the convenience of the typists, but it was also a convenience to the manufacturer. Works production engineers should very seriously consider whether the finishes that they were applying to manufactured articles were the most suitable for manufacture, and whether an alteration would enable the operatives to get a better view of their work, and so lead to increased production. The war had revealed many defects in the national economy, and it had rammed home the absolute necessity for good artificial light when people had to work such long hours on production. Even though it were only in use for one hour instead of the whole day, as it was in many cases, good lighting brought its reward to employer and operative.

He was very interested in Mr. Weston's remarks concerning the passage of a general law requiring that lighting should be sufficient and suitable for the job. Whether such a law was practicable and what Ministry should be responsible for its enforcement were obvious questions that would arise, but the matter might well form the subject of a special session of the Legislation Sub-Committee of the Reconstruction Committee. He agreed with Mr. Weston that very much more careful study was needed of illumination values for special processes, and as Chairman of the Reconstruction Committee he would have great pleasure in bringing the matter before them.

Mr. H. C. WESTON, in reply, said he was sorry that he appeared to have hurt the feelings of the Ministry of Labour in his remarks about their Regulations. It would be remembered, however, that in the Fourth Report of the Departmental Committee it was very clearly stated that its recommendations were not to be regarded as standards of good practice, and only the minimum illumination for working areas was altered in the Fifth Report. While the present lighting regulations would achieve a great deal, and if they could be properly enforced there would probably not be a great deal of complaint, there seemed to be a general feeling in the I.E.S. that they did not go far enough and that better conditions could be established. It would be a pity, and, he thought, contrary to the intention of the Departmental Committee, if the Regulations were accepted as standards of good practice.

If he had conveyed the impression that tungsten lighting was a thing of the past, this certainly was not his intention. Fluorescent tubular lighting was a godsend at the present time; in some cases it had proved to be a complete solution of the black-out problems, and he was quite sure that it had a great future. His suggestion was that the method of using tungsten sources should be improved, that they should be made less obtrusive, and that low brightness fittings should be developed for them. Subject to that remark he had nothing to say against them.

Obviously, in many situations they were the most convenient type. His main point was that, whatever type was used, it should be unobtrusive.

Dealing with the economic aspect, Mr. Weston felt that desirable ideals could be afforded if there was the will to afford them.

Mr. Smith had rightly emphasised that they must not approach the problem of reconstruction solely from the point of view of building. In the author's opinion good lighting was a social technique which the State itself should deliberately use to promote the happiness, contentment, and solidarity of society. There were many such techniques apart from that of pure and obvious propaganda.

NOTES ON RECENT MEETINGS AND EVENTS

Sessional Meetings in London

Following the opening meeting of the session,* at which the Presidential Address was delivered, two sessional meetings have been held.

On November 11 Mr. H. C. Weston delivered his paper on "Industrial Lighting in Reconstruction," in the course of which he emphasised the importance of taking a broad view of the functions of lighting in factories and illustrated the effect on workers of such factors as diffusion of light and a congenial background. The subsequent discussion was opened by Mr. H. E. Chasteney (H.M. Deputy Chief Inspector of Factories) and was continued by Mr. A. E. Iliffe, Mr. E. W. Murray, Dr. J. W. T. Walsh, Mr. Geo. Smith, Mr. A. Cunnington, Mr. F. C. Smith, Mr. L. G. Applebee, Mr. J. S. Dow, and Mr. R. Maxted. In the unavoidable absence of the President the chair was taken by Mr. R. O. Ackerley (Vice-President).

On December 9 a paper on "Infra Red Radiation and Equipment: their Application to Industrial Processes" was read by Mr. R. Maxted, who reviewed the physical basis of the problem and discussed available equipment and its application in industry. Those who took part in the discussion included Mr. G. W. Humphries, Mr. J. Matthews, Mr. F. C. Smith, Mr. J. B. Carne, Mr. L. E. Buckell, Mr. E. W. Murray, Mr. A. L. Roberts, Mr. G. O. Leman, Mr. H. A. Newnham, and Mr. C. E. Greenslade. The President (Mr. W. J. Jones) presided.

Both meetings took place in the lecture theatre of the E.L.M.A. Lighting Service Bureau (2, Savoy-hill, London, W.C.), and the votes of thanks accorded to the authors of the papers were coupled with expressions of appreciation of the hospitality of the Bureau.

Lecture before the Royal Society of Arts

On November 19 a lecture on "Lighting in War-Time" was delivered to the Royal Society of Arts (London) by Mr. J. S. Dow, Mr. Percy Good presiding. Mr. Dow recalled that the inaugural meeting of the Illuminating Engineering Society was held in the lecture theatre of the Royal Society of Arts on November 18, 1909—almost exactly thirty-two years ago. The lecture reviewed recent developments in industrial lighting and the introduction of legislation thereon, after which the author discussed and illustrated various aspects of the work conducted by I.E.S. committees in connection with war-time street lighting, the measurement of low brightness, fittings for low illumination, and the nature of twilight vision. After quoting statistics to illustrate the relation between road accidents and the black-out the lecturer repeated some of the experiments previously shown at I.E.S. meetings, illustrating the degree of visibility at illuminations down to 0.0002 ft.c. Mr. Dow concluded by expressing, on behalf of the Society, its indebtedness to the many members who had shared in the experiments initiated by the Joint Committee of the Ministry of Home Security and the Society, to Mr. Good, its chairman, and to Dr. Stradling, the Ministry's Chief Adviser on Research and Experiments, for his constant co-operation and encouragement.

* Trans. Illum. Eng. Soc. (London), Oct., 1941, p. 128.

Formation of New Groups

In addition to the existing I.E.S. Groups in the South Wales and North Eastern areas, which were duly recorded in the Transactions, the Council has now accepted a request for the formal initiation of a Group in Bath, where Mr. W. C. Bowler has been elected chairman, and Mr. R. E. Tucker honorary secretary. This decision was announced at a meeting held in Bath on December 10 by Mr. R. O. Ackerley, who gave an address to members present.

There has recently been a very considerable influx of members from the west of England. It is hoped that in the near future a Group will likewise be established in Bristol, which is to be visited by the President during January next, and that ultimately the strength of both Groups will be sufficient to justify their participation in the formation of a new centre in the West of England.

In other areas good progress is also being made. The President has accepted an invitation to address the North Eastern Group, which is at present associated with the North Midland Centre, at a meeting to be held in Newcastle on January 8, and on January 21 he is paying a similar visit to Leicester, where preparations for the formation of a Group, which is intended to operate under the wing of the Nottingham Centre, are also being made.

Forthcoming Meetings

Jan. 13th, 1942. Dr. J. W. T. Walsh on **Planning for Daylight** *(Sessional Meeting to be held in the Lecture Theatre of the E.L.M.A. Lighting Service Bureau, 2, Savoy Hill, London, W.C.2.)* **2.30 p.m.**

It is proposed to devote the subsequent Sessional Meeting in London, provisionally arranged to take place on February 10, to a discussion on Present and Future Lighting Problems. Members who have met with and solved problems of interest at the present moment, or have ideas on the solution of special problems in Post-war Reconstruction, are invited to get in touch with the Honorary Secretary.

Jan. 11th, 1942. Mr. J. N. Aldington on **Fluorescent Light Sources** *(Meeting of the I.E.S. North-Western Centre at the Manchester College of Technology, Sackville-street, Manchester.)* **2.30 p.m.**

Meetings of Centres and Groups

The Honorary Secretary would be glad to receive, from the officers of the various Centres and Groups, full particulars of meetings and other functions, as and when arranged, in order that appropriate reference to these may be made under the heading of "Forthcoming Events."

It would also be advantageous if he could receive a brief report (of, say, up to 250 words) of procedure at such meetings, with a view to publication.

Additions to List of Members.

The following applicants have been duly elected by the Council to membership in the Society and their names have been added to the list of members*:

CORPORATE MEMBERS:—

Chown, F. C. .....Metropolitan Vickers Electrical Co., Ltd., Northumberland Road, NEWCASTLE-ON-TYNE.

Claydon, E. C. .....“Hilltop,” Milton Avenue, BATH.

Dickinson, S. .....124, Fountain Street, MANCHESTER.

Elliott, W. .....89-90, Frederick Street, CARDIFF.

France, Lewis A. .....45, Milton Road, Nether Edge, SHEFFIELD, 7.

Gomersall, J. .....Imperial Buildings, Oxford Road, MANCHESTER, 1.

Hayward, A. W. .....53, Third Avenue, Oldfield Park, BATH.

Hill, J. C. .....22, Lytham Road, MANCHESTER, 19.

Horrobin, W. L. .....58, Summer Row, BIRMINGHAM, 3.

Jameson, H. .....“The Kraal,” South Hylton, Nr. Sunderland, Co. DURHAM.

Nation, E. W. .....558, Wells Road, BRISTOL, 4.

Pattison, E. W.....7, King George Road, Fawdon, NEWCASTLE-ON-TYNE, 3.

Rhodes, J. Otley .....Arcade Chambers, High Street, Newport, MON.

Royle, T. .....7, Grange Park Avenue, ASHTON-UNDER-LYNE.

Sancto, W. .....24, Cardigan Terrace, NEWCASTLE-ON-TYNE.

Tuppeny, H. L. .....40, Dene Hollow, King's Heath, BIRMINGHAM.

ASSOCIATES:—

Smith, K. Oldham ....3, Greenhill Road, Griffithstown, Nr. Pontypool, MON.

STUDENT MEMBERS:—

Wilcock, A. .....15, Argyle View, LEEDS, 9.

* In accordance with the present procedure the names of applicants for membership are published in THE TRANSACTIONS as soon as such applications have received the approval of the Council and the subscription for the current year has been duly paid.

Transference from Country Membership to Corporate Membership.

Brangwin, K. C. .....105, The Boulevard, Wylde Green, SUTTON COLDFIELD.

Baker, A. W. .....20, Alexandra Road South, MANCHESTER.

Bisson, G. ..... 21, Ladbroke Road, Solihull BIRMINGHAM.

Crammond, L. C. . Rutlands, Boundary Road, West Bridgford, NOTTINGHAM.

Freeman, C. F. .....Wood Lane, Shilton, Nr. COVENTRY.

Green, W. H. .....15, Frankley Avenue, Quinton, BIRMINGHAM.

Hare, L. A. .....8, Chatham Street, MANCHESTER.

Hoskins, C. H.....27, Beacon Road, SUTTON COLDFIELD.

Loynes, W. A. .....25, Hillyfield Road, Erdington, BIRMINGHAM.

Nott, G. S. .....71, Shakespeare Street, COVENTRY.

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The Physiology of Vision

The second meeting of the Session of the Scottish Centre took place in Glasgow on December 17, when Mr. E. J. Stewart (Chairman of the Centre) presided. Dr. Arthur Anderson, of the Glasgow Public Health Dept., gave an address on "Physiology of Vision," which included a comprehensive series of lantern slides and models dealing with the operation of the muscles and nerves of the eye, and defects of vision. The lecturer discussed many interesting points, such as the operation of the rods and cones, the importance of the fovea centralis, the blind spot, and the generation of rhodopsin by the assimilation of vitamin "A." Familiar optical defects, such as long- and near-sightedness, were also illustrated and explained. A good discussion followed, in which Mr. J. Dickson, Mr. T. Nisbett, Mr. F. M. Hale, Mr. S. G. Batt, and Mr. M. W. Hime took part. A vote of thanks to the lecturer, moved by Mr. H. J. H. Scott (vice-chairman), was carried with acclamation.

The Illuminating Engineering Society is not, as a body, responsible for the opinions expressed by individual authors or speakers.

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Printed by the ARGUS PRESS, LTD., Temple-avenue and Tudor-street, London, E.C.4, England.